The Satin Moth in British Columbia

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THE SATIN MOTH IN BRITISH COLUMBIA

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INTRODUCTION

The satin moth, *Stilpnotia salicis* L, is a native of Europe and Western Asia; it is a beautiful insect, pure white in colour and measuring two inches across the wings. The caterpillars feed on poplar and willow. They are conspicuously marked with blue-grey and reddish-brown and have clear white or yellow patches down the back. They measure nearly two inches in length when fully grown.

These caterpillars were first found in British Columbia in July, 1920, defoliating Lombardy poplars in New Westminster. The satin moth is a near relative of the gipsy and brown-tail moths, the attempted control of which in the Eastern United States has cost many millions of dollars.

HISTORY AND DISTRIBUTION

The occurrence of the satin moth in the British Isles and on the continent of Europe has been noticed for several hundred years and although apparently very abundant at times, its food plants, poplar and willow, being of little economic importance, it has not received the attention of a major pest.

The insect is recorded from practically every country from Scotland to Spain, eastward to Russia and Asia Minor, and in Eastern Asia, including China and Japan, the variety *candida* Stgr. occurs.

The insect was discovered on the Atlantic sea-board near Boston, Mass., U.S.A., in July, 1920, and at the end of that year investigation showed that it covered an area of seven hundred square miles in the states of Massachusetts and New Hampshire.

In British Columbia the infested area has increased considerably since the first edition of the pamphlet was issued in 1924. On the lower mainland this insect is now common from Vancouver at the coast to as far east as Agassiz and Rosedale in the Fraser valley. On Vancouver island it now extends up the east coast of the island north from Victoria as far as Comox. It also occurs at points on the coast of the mainland extending at least to Powell River, about 100 miles north of Vancouver.

In July, 1920, this insect was first found in the city of New Westminster, B.C., on two Lombardy poplars. These must have been infested in 1919 or earlier. The flight of moths in that year resulted in the infestation of practically every Lombardy and white poplar in that city and a few moths also reached Maillardville, a village about two miles east, where a number of Carolina and Lombardy poplars were infested for the first time. The insect was also noted sparingly on the native cottonwood (*Populus trichocarpa*) in and around New Westminster.

In the summer of 1921, injury was found on poplars in Vancouver, B.C. Scouting indicated that the centre of the outbreak was located in the residential section of Fairview, just south of False creek, Vancouver. The trees affected were white and Lombardy poplars and the infestation was greater than that at

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New Westminster. Our opinion of the original place of introduction was thereby altered and it appears from present knowledge that the Fairview outbreak was the source of original introduction into British Columbia.

Examination of the street trees in Vancouver showed that until 1919 the area was confined to two city blocks, but in 1920 a considerable spread was made and in 1921 a still greater spread occurred when practically upon every tree for a distance of five miles eggs were found.

In 1921, the insect was also discovered at Cowichan bay, B.C., where twenty-five large trees of white poplar were badly attacked. It is regarded as probable that this area became infested in 1919 from moths carried on steamers trading between Vancouver and this point.

The other outbreak of the satin moth on Vancouver island was discovered in June, 1922, in Nanaimo, and fortunately we have rather more definite data as to its time of arrival. In July, 1920, the writer made an examination of the poplar trees in Nanaimo. No summer feeding by this insect was found and it is, therefore, altogether likely that the first moths arrived during the latter half of July, 1920. No report of an outbreak was received in 1921 and in that year Nanaimo was not visited. In 1922, an outbreak occurred and the municipal authorities became greatly exercised over what was an exceedingly bad infestation. Fire engines were requisitioned to remove the thousands of crawling larvae from fences and sidewalks.

Seven Lombardy poplars, the identical trees examined in 1920, were totally defoliated and the larvae, not yet fully fed, though in the last instar, were migrating in search of food. Fifteen to twenty other poplars were in various

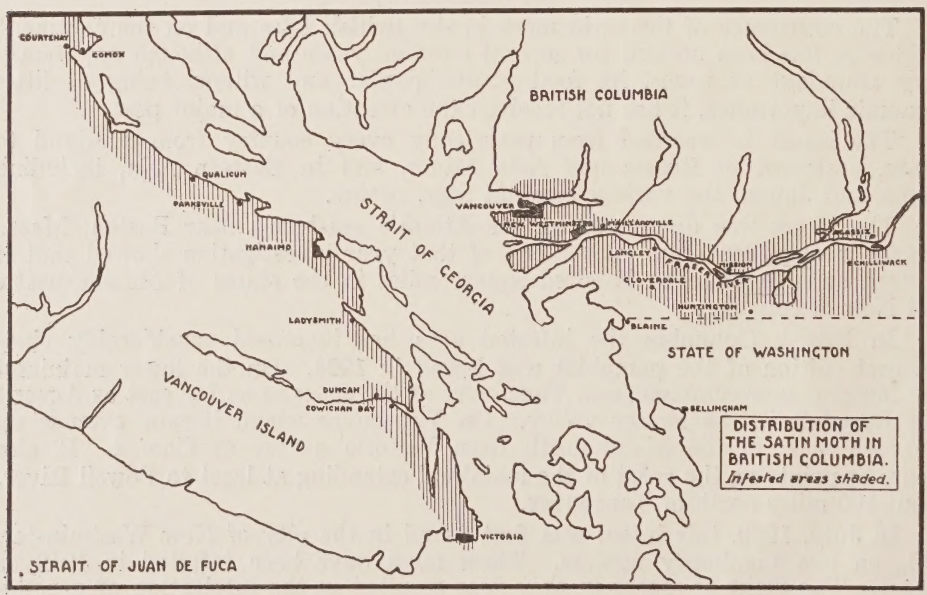


Fig. 1.—Distribution of the satin moth in British Columbia. Infested areas shaded (original).

stages of defoliation—from 30 to 60 per cent. It will thus be seen that in the absence of natural or artificial control, the insect may within two years become so numerous as to cause a serious outbreak. In 1923, this outbreak was very much reduced, hardly any defoliation taking place. The reason for this was not evident, but these sudden fluctuations are of common occurrence in Europe.

Evidence of continued spreading was found in 1922, outbreaks being located at Qualicum and Duncan on Vancouver island, the latter place being undoubtedly infested from the Cowichan bay outbreak about four miles away.

In 1923, incipient stages of an outbreak were noted in Victoria. An examination of numerous poplars failed, however, to show any fall feeding by the caterpillars, but owing to heavy defoliation by the saw-fly, *Trichiocampus viminalis* Fall., satin moth larvæ may have been present although the results of their feeding were indistinguishable; in the young stages both of these insects are epidermal feeders.

There is no definite knowledge in regard to the introduction of the satin moth into British Columbia. Vancouver city appears to have been its first breeding place. Its introduction from Europe was doubtless in the hibernating larval stage, either on nursery stock or in packing cases, quite possibly the latter since the hibernaculum is spun in any place giving suitable protection. None of the other stages of the insect are of sufficient duration to withstand a journey from Europe.

DESCRIPTION OF THE INSECT

The Egg

Pale green when first laid, darkening to brown before hatching; spherical, slightly flattened; .75 mm. in diameter; one or two layers of eggs in flat masses covered with a white froth. Masses roughly oval in outline 10 to 20 mm. in width, consisting of from 100 to 200 eggs laid indiscriminately on the leaves, branches, trunks, adjacent fences or buildings.

The Larva

First stage.—Length 2 to 3 mm., head dark, .45 mm. wide; body pale brown with darker tubercules, each bearing tufts of pale hairs; thoracic legs black, prolegs paler; a dark brown patch on the dorsum of the first thoracic and the first and second abdominal segments.

Second stage.—Length 4 mm.; head .58 mm. wide; colouring similar to first stage but darker; dorsum of second and third thoracic, and third, fourth and fifth abdominal segments white; eighth and ninth abdominal segments also lighter on dorsum.

Third stage.—Length 5 to 7 mm.; head .65 mm. wide; larva similar to second stage but darker in appearance owing to contraction to 4 mm. or less, for hibernation.

Fourth stage.—Length 6 to 8 mm.; head .9 mm. wide; more hairs on the body but otherwise similar to third stage.

Fifth stage.—Length 12 mm.; head 1.5 mm. wide; much brighter in general appearance than previous stage; tubercles now reddish-brown; white areas on dorsum larger and brighter, those on first and second abdominal segments smaller.

Sixth Stage.—Length 20 mm.; 2.5 mm. wide; white areas on dorsum now more conspicuous.

Seventh stage.—Length 40 mm., head 4.2 mm. wide, greyish beset with hairs; dorsum black, broken with a row of large white or cream coloured areas down to centre and edged with a thin white interrupted line; sides finely mottled with black and white, giving a blue-grey appearanre; each segment with a transverse row of reddish-brown raised tubercles; hairs from tubercles reddish to tawny with several black ones arising from the first thoracic segment and extending over the head; thoracic legs black; prolegs and venter greenish; on the first and second abdominal segments there arises from the centre of the dorsum a black forked process 1 mm. high and from each of the sixth and seventh abdominal segments in a similar position is an eversible gland, reddish when extruded.

The Pupa

Shiny black, 20 to 25 mm. long, 6 to 8 mm. wide, with one or more rows of pinkish spots on the abdomen; the whole pupa clothed with copious, golden-yellow* hairs, 2.5 mm. long, fading with age to a tawny colour. The cocoon consists of a few threads of silk sufficient only to hold the pupa to the crevice, twig, leaf or other object, chosen by the caterpillar for transformation.

* These hairs are described as being white in "Barrett's Lepidoptera" and in the notes on this insect in the Massachusetts outbreak.

The Moth

Expanse 40 to 60 mm.; males somewhat less. Length of body male 15 mm., female 20 to 25 mm. Teeth of antennae black, shaft coated with white scales. Head, thorax and abdomen black but appearing almost white from heavy covering of pure white hairs and broader scales. Hair most abundant on head, thorax and tip of abdomen. Femur black with white hairs; tibia and tarsus with adternate transverse bands of black and white scales. Wings, both fore and hind, clear white with a satiny lustre; veins slightly yellowish, becoming more so with age.

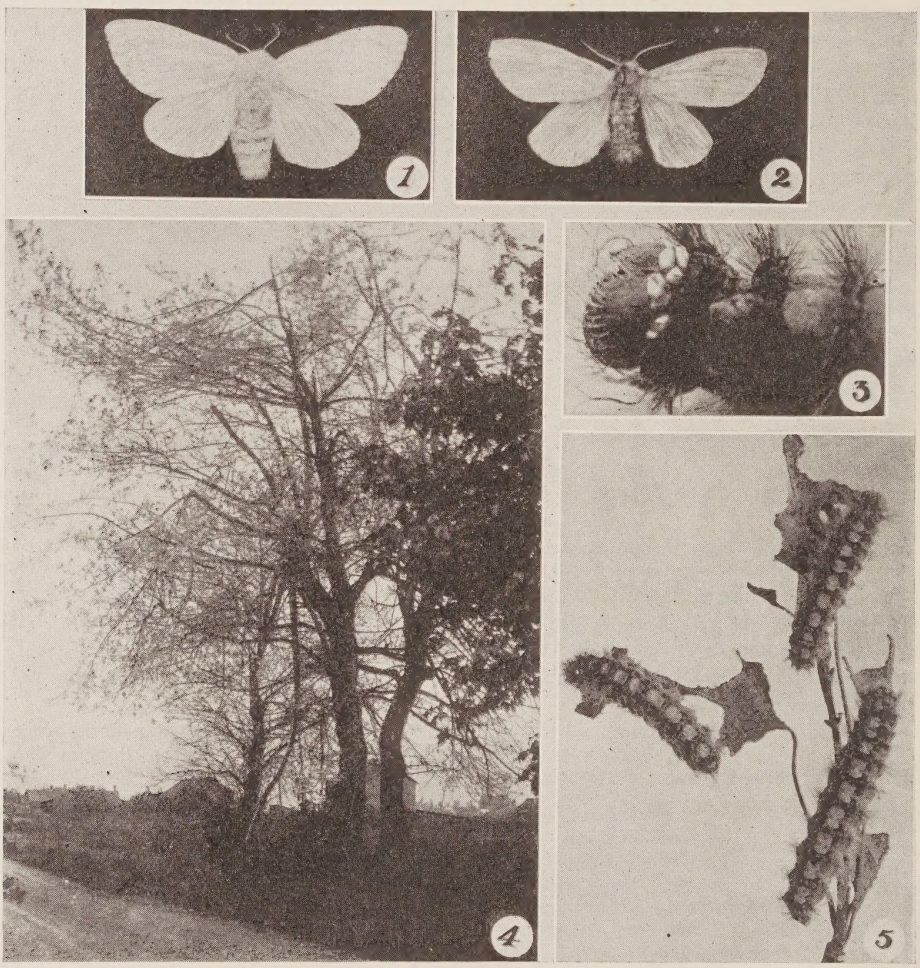


Fig. 2.—Satin moth; 1, female moth; 2, male moth; 3, caterpillar with tachina eggs on head; 4, white poplar defoliated by caterpillars, maple tree at right; 5, full grown caterpillars feeding on poplar (original).

LIFE-HISTORY AND HABITS

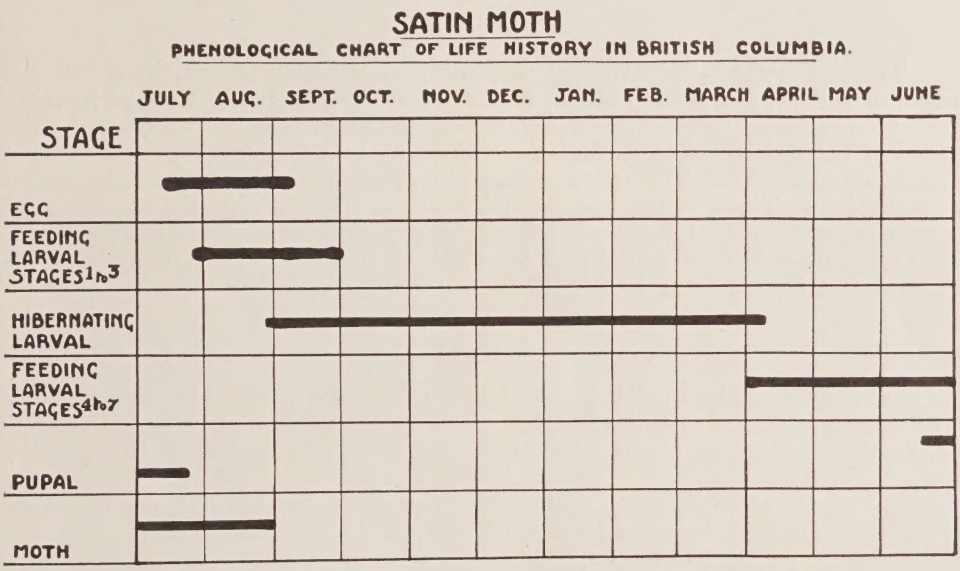
Hatching

The eggs hatch in from thirteen to sixteen days, according to temperature; the period when hatching is in progress extends from the middle of July until the last week of August, the maximum period being a month after the height of

pupation, or the first week of August. The young larvæ release themselves from the egg mass by chewing several to many holes through the frothy covering.*

Feeding

The larvæ commence feeding by chewing either the lower or upper epidermis of a leaf, leaving portions skeletonized with the veins showing. The first moult occurs after six days' feeding, and takes from three to four days. A thin web, only, is spun for this moult, either on the back of a leaf or in a crevice in the bark. The second stage larvæ continue feeding in a similar manner for about seven days. Each larva then commences to spin a hibernaculum, which takes the best part of a day. This consists of a fairly stout, cocoon-like structure of silk, slightly larger than the insect itself. This is spun in a protected place such as in the crevice in a tree trunk or crack in a fence. The underside of a limb is a favourite place, and on occasion a number of larvæ will spin their webs one on top of the other, completely filling a crevice one-quarter inch deep. When crevices are scarce or insufficiently deep a slight excavation is made by chewing the tender bark at the bottom of an opening fissure.



Before retiring for the winter in this hibernaculum the larva moults again, the cast skin and head capsule being left on the outside of the web. The earliest date that hibernation occurred was August 15, and practically all are in hibernation by the middle of September, except those feeding on the cottonwood, which may be often found until the end of the month.**

Seven months are spent as hiberating larvæ, the first emergence from the winter webs taking place about April 20. The poplars are then commencing to leaf and the young larvæ again feed on the epidermis as in the autumn. After feeding for about ten days, the third moult takes place and occupies two days. The larvæ descend to the trunk for this moult and spin a slight web over a crevice in the bark.

* A batch of larvæ hatched in the laboratory and not fed, chewed this frothy covering to pieces but apparently none was swallowed and its nourishing effects were not evident.

** It was considered that larvæ reaching their second moult as early as August 15 would continue to feed through another instar before hibernating. This, however, did not occur though the weather was fine and warm.

The fourth stage larvæ eat the whole of the leaf substance instead of skeletonizing it as in previous instars, feeding continuing from ten to twelve days, when the fourth moult takes place. The larva often does not descend to the trunk for this and subsequent moults, but draws the edges of a leaf together with a few strands of silk and makes the change there, but numbers of larvæ still leave the foliage for moulting and may be found in masses in a protected position on a limb. This is more often the procedure when heavy defoliation is occurring, and consequently fewer leaves are available for moulting. The fifth, sixth and seventh stage larvæ each feed from ten to twelve days, the intervening moults occupying from two to three days.

The periods of feeding were very irregular and no exact statements can be made to cover all conditions, as some larvæ would be resting while others were feeding at all times of the day and under different weather conditions. However, when wet or dull, in the younger stages the larvæ were often found resting on the petioles, on the twigs or on the rough bark, and feeding appeared more prevalent during warm bright weather. With the later stages, however, this was reversed, and in the last stage feeding was more continuous, the patter of the falling frass under a badly affected tree sounding like rain.

Pupation

This takes place in a variety of places, on the main trunk, in a leaf the edges of which have been enrolled, under a fence rail or under the overhanging roof of a shed. Pupæ are, also, sometimes found in bunches attached to the twigs of the defoliated trees, and the side of a building even fifty feet from a tree is often chosen. The larva spins a flimsy cocoon and pupation occurs in any position. The average time occupied in pupation is nine days. The first moths appear early in July and emergence continues until the end of August. Upon coming out of the pupal case the moth crawls a few inches and the wings expand and dry in from two to three hours.

Mating

Mating takes place a few hours after emergence and may last twelve hours. The usual position is with the heads in opposite directions, the male head downwards with the wings overlapping those of the female, antennae beneath the wings.

The males often copulate with more than one female and this is probably the usual course, as from data collected in 1922 the females predominated over the males by nearly two to one.

Flight

The moths fly both during the day and the night, and are attracted to street lights to some extent, especially the males. They are tolerably strong on the wing and with the wind can be dispersed a distance of from two to five miles and possibly further without injury. The great majority, however, do not fly far and at the height of mating, the tops of heavily infested poplar trees appear alive with the fluttering moths which in their excitement resemble the swarming of bees.

Egg-laying

This operation commences very soon after fertilization has taken place, sometimes within an hour, and may continue with intervals of rest for five days, but two days are usually sufficient for a female to deposit her complement of eggs.

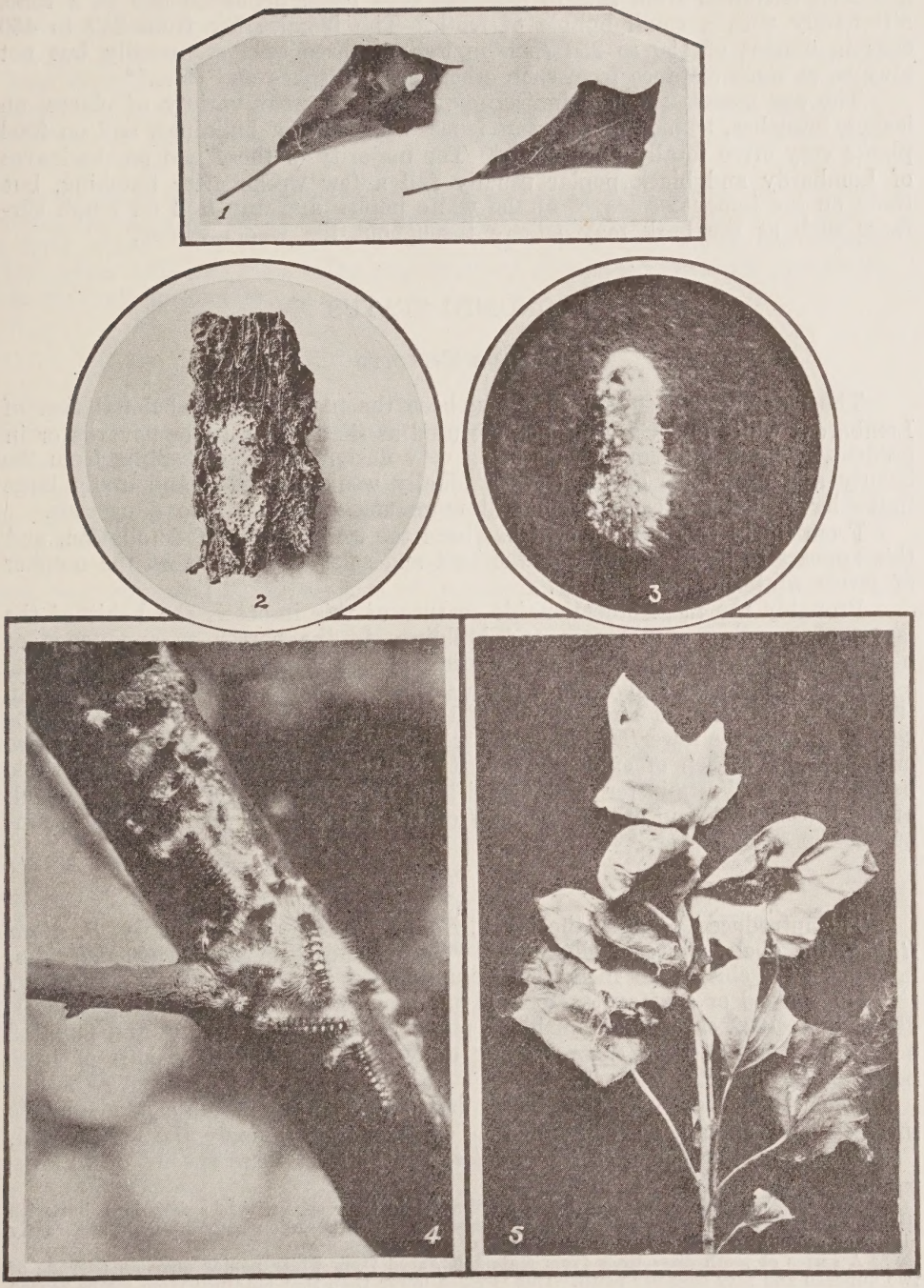


Fig. 3.—1, satin moth larvæ in folded poplar leaves; 2, hatched egg-mass on poplar bark; 3, dead larva enveloped in fungus; 4, last stage larvæ and cast skins on poplar limb; 5, pupæ in rolled leaves of white poplar.

An egg mass of average size takes from one to two hours to deposit. The abdomen is moved from side to side, the eggs being deposited one at a time, alternately with a small bubble of froth.* The females lay from 250 to 450 eggs in masses of 150 to 250 each in two or three batches, usually but not always, at some distance from each other, both in space and time.**

The egg masses are laid indiscriminately in a great variety of places, on leaves, branches, trunks, or adjacent fences and sides of buildings, and on food plants very often totally unsuitable.† The majority of those laid on the leaves of Lombardy and black poplar usually fall a few weeks after hatching, but those on the tomentose leaves of the white poplar and any laid on rough surfaces such as the bark may adhere throughout the whole winter.

ECONOMIC STATUS

Damage Effected

The chief damage up to 1927 had been the partial or total defoliation of Lombardy, white and Carolina poplars used as shade trees on boulevards or in gardens. This defoliation besides being very unsightly and detracting from the beauty and usefulness of the trees gradually weakened them and many large limbs have died rendering them still more unsightly and also dangerous.

From thirty to sixty per cent has been the usual extent of defoliation, and this appears to be irrespective of the host and solely dependent on the number of larvæ wintering successfully.

Probably the most objectionable feature of this insect is the habit of the larvæ of crawling over fences and buildings to the horror or annoyance of nearby dwellers, and in this habit it probably eclipses the tent caterpillars.

During the past two years a more serious aspect of damage has arisen in the total defoliation of large stands of the native cottonwood, *Populus trichocarpa*, all over the lower Fraser valley from New Westminster eastward. These outbreaks have been of epidemic severity and have been especially noticeable between New Westminster and Coquitlam, near Ruskin on the north bank of the Fraser river and around Langley on the south bank, with isolated groups of trees in other places.

Food Plants

The introduced poplars, the black, *Populus nigra*, the Lombardy, *P. nigra italica*, the abele, white or silver-leaf, *P. alba*, and the Carolina, *P. deltoides*, have been the chief hosts in British Columbia.

No marked or constant preference has been noted for any of these species, although in 1922 caterpillars on black poplar had finished feeding and pupated a fortnight earlier than those feeding on white poplar, both groups of trees being in the same city block.

Since 1926, however, this insect has shown a remarkable tendency to increase and spread on a number of native trees, namely the cottonwood, *P. trichocarpa*, the aspen, *P. tremuloides*, and at least three species of willows,

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* Two females confined without being fertilized laid their eggs within a few days, but with little or no frothy covering. They were, of course, infertile, the union with the male apparently aiding or stimulating the secretion of the froth.

** A series of moth dissections from material reared from white poplar gave an average of two hundred and fifty eggs per moth. This is much lower than that obtained from moths reared on Lombardy poplar which averaged over four hundred.

† Twenty-five egg-masses were counted on July 28, 1921, on the faces of the clock on the tower of the Burns Building, Vancouver, B.C. This building is nearly 250 feet high, and the clock is illuminated at night which probably accounts for the eggs being there. This apparent carelessness is, however, no doubt occasionally the means of dispersal to fresh locations, when the eggs are laid on movable objects.

viz.; *Salix sitchensis, S. scouleriana* and *S. lasiandra,* and in 1928 large groups of these trees were totally defoliated in different parts of the infested area from Vancouver island to Chilliwack.

When first noted, in 1920, very little infestation was found on cottonwood in New Westminster, but in 1921 and 1922 more trees were seen to be affected, probably owing to the degree of infestation being more severe. The amount of defoliation on the worst infested tree in 1922 was probably not more than twenty per cent.

From experiments conducted in 1922 and from subsequent observations, it would appear that this insect has pronounced inherited adaptability to different food plants. Outbreaks in one locality are often confined to one species of tree, other adjacent hosts being slightly if at all infested, and this preference being reversed in another area.

Future Importance

From the foregoing the comparative rapidity of adaptation being made by this insect is observed, and from this evidence its future economic importance assumes a graver aspect.

The cottonwood is a large tree, fully as high as the largest Lombardy poplar, eighty to one hundred and twenty-five feet high on an average, and is very plentiful in British Columbia. It is estimated that there are seven hundred and eighty million board feet in the province,* and the wood is in demand for boxes, veneers, and the better class of pulpwood, with a growing appreciation of its value.

Should these stands of cottonwood continue to be defoliated for several years they would be greatly weakened and their value would seriously depreciate. None of the willows are of any economic importance and the damage to them would be largely of an esthetic nature.

In an endeavour to prevent the introduction of this insect into the interior of the province where much damage might accrue to the poplar windbreaks adjacent to orchards, Regulation No. 9 (Domestic), Destructive Insect and Pest Act, prohibits the movements of poplars and willows from the coast to points in the interior.

Natural Control

The following factors in natural control have been observed in connection with the satin moth in British Columbia:—

Winter mortality.
- In hiberating larvæ.

Parasites.
- Sarcophagid flies,
- Tachinid flies,
- Hymenopterous flies.

Predators.
- Birds,
- Bats.

The chief of these has been the first, that is, the mortality of the larvæ in the winter.

Of the several other factors, that of parasitism by tachinid flies is the only one to reach measurable standards.

* Forests of British Columbia; Whitford and Craig, Commission of Conservation, 1918.

Single hymenopterous flies, generally braconids, of several genera, have occasionally been reared from pupæ from different stations, and a small chalcidoid fly has on several occasions been found ovipositing on pupæ and has been reared therefrom.

Predators noted have been western robins (*Planesticus migratorius propinquus*) and bats, but neither of these can be considered as important factors.

Winter Mortality

In the study of this insect in British Columbia it has been found that great mortality often occurs during the winter months, when, hibernating as a third stage larva, it is exposed to the vicissitudes of climate.

The exact cause of death is not known, but considerable numbers of the larvæ are each year found dead often enveloped by a white fungus. That this fungus is not *always* the cause of death is proven by observation which shows larvæ dead without sign of fungus upon them and these when collected fail to develop the fungus.* Specimens of the larvæ infested with the fungus were forwarded by the Dominion Entomologist to Dr. P. Vuillemin, Malzeville (near Nancy), France, who reported that the species was a new one belonging to the genus *Spicaria*. It has since been described (Can. Ent. LVII, 97) as *Spicaria canadensis* Vuil.

Early in November, on the trunks of the poplars, the larvæ may be seen in their webs with here and there one covered with fine, white, hyphal threads which, growing on the dead larvæ, emerge through the webs. The fungus is more common on the wetter portions of the trunk and appears there first.

Counts of the larvæ affected with the fungus on specially marked areas on the trunks of some poplar trees in New Westminster were made during the winter of 1920-21, and showed an increasing amount of mortality from November to March. The figures from three of these areas are tabulated below, and show individual fluctuations and average percentage of infection for each month.

	Area 1		Area 2		Area 3		Percentage dead
	Alive	Dead	Alive	Dead	Alive	Dead	
1920							
December 7	20	7	30	11	22	2	21·7
1921							
January 5	5	15	17	14	3	18	65·3
February 11	6	17	12	20	7	18	75·07
March 9	0	19	2	12	3**	16	90·04

It will thus be seen that during the winter of 1920-21 ninety per cent of the larvæ succumbed. This was borne out by subsequent observation and a similar rate of mortality occurred in 1921-22, in Vancouver and New Westminster, and was solely responsible for keeping within reasonable bounds the outbreaks during the following summer in these places. However, in Nanaimo, the outbreak in 1922 was quite out of hand and apparently could not have had this controlling force to such an extent. This may be attributable to drier climatic conditions as more larvæ survive on drier portions of the tree.

* On September 9, 1921, after a night with a slight frost, larvæ were observed by thousands hurriedly descending from the leaves for hibernation, some suspended by threads, others crawling down the branches and trunks which were swathed in threads. Great numbers of these larvæ failed to spin proper hibernaculæ and were found dead early in October in putrifying masses.

** The occasional apparent discrepancies in the figures from month to month are caused by dead larvæ falling off or by live larvæ moving their quarters, which may often be noticed on fine mild days.

During recent years this fungus has always appeared in the second or third season in a new infestation, causing a heavy mortality of the overwintering larvæ, with a consequent reduction of the subsequent defoliation from 100 per cent to varying amounts from 50 per cent downwards.

Parasites

Diptera.—Two species of tachinid flies have been reared from satin moth larvæ, namely, *Tachina mella* Walker, and *Tachina robusta* Tn. These are species which normally have as hosts such native lepidoptera as the tent caterpillars (*Malacasoma* spp.) and the woolly bear (*Isia isabella* A. & S.) and it is interesting to note their occurrence on an introduced insect.

In 1921, a few satin moth larvæ were noticed at New Westminster bearing typical white tachinid eggs. A number of these larvæ were collected and reared but no parasites were obtained as the eggs were cast off in moulting before they hatched.*

Several batches of pupæ were collected in New Westminster and Vancouver. These yielded but few parasites, usually about four per cent of the above-mentioned tachinids; the highest obtained was ten per cent from New Westminster material.

In 1922, tachinid parasitism was much more in evidence. In New Westminster on one row of Lombardy poplars, while tachinid eggs were noted very freely on the larvæ. Counts of infested larvæ showed sixty-four per cent parasitized. Some larvæ bore as many as twenty eggs each. On June 21, further counts were made in different localities in New Westminster, the results varying from twenty-five to eighty per cent parasitism. The majority of these eggs, being laid shortly after the last larval moult, hatched before being shed at pupation, and the great majority thus proved fatal to their hosts and were an appreciable control factor in this location. In Vancouver, few tachinids were noted in 1922. In Nanaimo, in 1922, the white eggs were very abundant but owing to the immense number of larvæ present the percentage was only about thirty-five.** In 1923, tachinids were much less in number and were negligible as a control factor.

The sarcophagids, *S. houghii* Aldr., and *S. aldrichi* Pk., and *Agria affinis* Fall, were also recovered in some numbers each year but have been a very small factor in control.

A quantity of egg masses were collected both in 1920 and 1921, but no parasites were obtained from them. The short egg period would give less opportunity to egg parasites than that offered by species of *Malacasoma.*

None of these parasites have been noticed in recent years and apparently cannot be relied upon to check this pest to any appreciable extent.

Hymenoptera.—Four ichneumonid flies, identified as *Ephialtes pedalis* Cress, and *Theronia fulvescens* Cress., were reared in 1921 and 1922. These attacked during the last larval or pupal stages, and emerged at varying dates in August and September.

A small chalcidoid fly, *Amblymerus lipardis* Vier., has been reared on several occasions from pupæ of the satin moth collected both in Vancouver and New Westminster; one pupa in 1920, three in 1921 and two in 1922, so that apparently it will be a very slight factor in natural control. The adult is metallic

* On one location in New Westminster where satin moth and tent caterpillars were feeding together on some poplar suckers it was noticed that whereas the satin moth larvæ were noticeably infested with tachinid eggs, the tent caterpillars were quite free. Satin moth larvæ are not so irritable in the presence of tachinid flies as are tent caterpillars.

** Numbers of larvæ collected here contained so many maggots of apparently equal vigour that very few completed their feeding and but few puparia were obtained.

green, 2 mm. long and not very active; they are pupal parasites and were observed ovipositing during July on pupæ in the field and in the laboratory, emerging in August. They, therefore, use some other host during the winter, or hibernate as adults.* A considerable number were reared from one host pupa, 28, 30, 27, 87, respectively, being recorded.

Predators

During the annual flight of the moths, western robins on several occasions were observed catching or picking them off the leaves or other exposed places. Thirteen robins were noticed engaged in this occupation in one location in New Westminster. The habit, however, is not general and has but slight effect on the number of moths present. Robins, also, have been seen to take larvæ, but very rarely.

While observing the attraction of the moths to street lights in New Westminster in July, 1921, several bats were seen chasing the fluttering moths. The wings were nipped off before the body was eaten. From the small number of bats seen and the few detached wings found, this natural control factor may be considered as being of little importance.

Artificial Control

While the nature of the pest allows it to be readily killed by a poison spray, such as arsenate of lead, the difficulty of throwing this spray to the tops of the tall Lombardy poplars or cottonwoods without a high-powered spray outfit has precluded any organized effort to exterminate it.

The height and inaccessibility of its host tree have also prevented any systematic collection of egg masses or pupæ, a measure of control of considerable value were its hosts less tall. As noted in the life-history, both the pupæ and the egg masses may be found in a great variety of places, on the trunks, fences, sides of buildings and on leaves, but under ordinary conditions not more than one-third are situated where they may be collected, making these measures of very little value.

The white poplar is a tree usually not more than forty feet high and ordinary orchard spray pumps could be used with good effect for the destruction of the caterpillars.

Arsenate of Lead Spray.—An experiment conducted in September, 1921, showed that the first and second stage larvæ may be killed readily by powdered arsenate of lead, one pound to twenty gallons of water, but a better time to apply this spray is about the middle of May when all the larvæ are feeding. Owing to the extended period of hatching, spraying in the autumn, if applied too early, would be very likely to miss many unhatched eggs, or if applied too late, a number of larvæ would have gone into hiberation and would not be reached.

In the spring-spraying, of Lombardy poplars in particular, soft soap should be added to the arsenate of lead as a sticker on account of the extreme smoothness of the leaves.

Coal Oil Emulsion.—In June, 1925, two blocks of boulevard trees in Vancouver, consisting of Carolina and Lombardy poplars badly infested by this insect, were sprayed (by the Parks Board under the author's direction) with a 7 per cent kerosene emulsion. The larvæ were nearly all in the last instar and

* Several dozen were fed on syrup and lived over a month in captivity but failed to oviposit on pupæ supplied probably owing to the pupæ being too advanced.

practically one hundred per cent control was obtained, the larvæ all succumbing in less than one hour. This spray has the advantage over lead arsenate in having better spreading qualities, and quicker action on the insects. No burning of the foliage took place.

Treatment of Nursery Stock.—Nursery stock, comprising the various poplars and weeping willows, grown in the infested area are likely to be affected and, as during the shipping season the insect is in hibernation on the stems and almost invisible, the larvæ may easily be transported to fresh locations. To prevent this an inspection of willows and poplars in nurseries is desirable. This is best carried out about the middle of September. All danger of further infection is then over and the leaves being still on the trees the evidence of fall feeding is readily noticeable, whereas the hiberating larvæ are difficult to find.

Where any evidence of fall feeding is found the stock affected should be dipped, before shipment, in a ten per cent oil emulsion bath, such as kerosene emulsion.

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